DOCUMENT RESUME

ED 342 609 SE 052 000

TITLE Black Achievers in Science, Teachers Guide.
INSTITUTION Museum of Science and Industry, Chicago, IL.
PUB DATE 88
NOTE 36p.; Contains some colored pages which may not reproduce well.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Biology; *Blacks; *Career Awareness; Career Choice; *Career Planning; Computer Science; Curriculum Guides; Elementary Secondary Education; Mathematics; Physical Sciences; *Role Models; Science Education

ABSTRACT

In this guide, 16 historical and contemporary black scientists and engineers are highlighted as role models. Four scientists are represented in each of four technical fields: life sciences (Ernest E. Just; Harvey M. Pickrum; George W. Carver; Patricia S. Cowings); physical science (George R. Carruthers; Percy L. Julian; Walter E. Massey; Warren M. Washington); mathematics and computer science (Fern Y. Hunt; David H. Blackwell; Marc R. Hannah; Benjamin Banneker); and engineering (Lewis H. Latimer; Norman R. Bliss; Christine M. Darden; Raphael C. Lee). Backgrounds of the men and women described include academia, industry, and government. The biographies include information about the scientists' educational background, professional achievements, and attitude towards their work; they also tell how these "black achievers" overcame tough challenges, highlighting qualities such as family background, determination, curiosity, and love of their chosen field, and other interests. Following each set of biographies is a career path chart for the technical area represented and each of these charts present information needed in planning for a career in science. As an aid in understanding the chronological ordering of these "black achievers" a reproducible timeline has been included, beginning with Benjamin Banneker (b.1731) and progressing to the present. Resource listings for professional organizations, publications dealing with careers, and publications used in producing this booklet are supplied. (KR)

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BLACK ACHIEVERS IN SCIENCE

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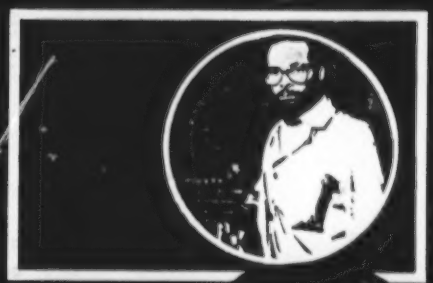
CHRISTINE M. DARDEN
Mechanical Engineer
1942

HARVEY M. PICKRUM
Metallurgist
1943

RAPHAEL C. LEE
Biomedical Engineer
1949



FERN Y. HUNT
Mathematician
1948

MARC R. HANNAH
Computer Graphics Artist
1956

SE 052 000

WALTER E. MASSEY
Theoretical Physicist
Administrator
1938

PATRICIA COWINGS
Psychophysiologist
1948

GEORGE R. CARRUTHERS
Astrophysicist
1939

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MUSEUM OF SCIENCE AND INDUSTRY, CHICAGO

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"Black Achievers in Science"
Teachers Guide

This guide for encouraging careers in science and technology was written and produced by the Museum of Science and Industry, Chicago. ©1988

This teacher guide was made possible by a grant from Citicorp/Citibank.

Designed by Rasheed Design, Inc.

Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of Citicorp/Citibank or the Museum of Science and Industry, Chicago.

INTRODUCTION

Science education is a basic need for everyone. Daily living and jobs increasingly demand more sophisticated technical training. Citizens in a democracy need to understand and make decisions about technological issues. Fundamentally, the reason for understanding science and mathematics is the same as that for all education—to allow individuals to lead more satisfying, fulfilling lives, enabling them to both appreciate and function intelligently in the world.

As a career, science or engineering is seen by many people as being unachievable. Science and mathematics courses are viewed as boring and unnecessary. This problem is particularly acute in the black community. The factors which have produced this problem are complex. Among them are the lack of relevancy, positive role models, and career information.

Black scientists and engineers have made outstanding contributions in their fields. Still, black youths are not aware of these historical and contemporary scientists as role models for their own career interests. Also, most youths do not realize the need for a strong, early education in mathematics and science or understand how to prepare for a scientific career.

To address these issues, the Museum of Science and Industry has produced "Black Achievers in Science." This exhibition celebrates the achievements of more than 100 historical and contemporary black scientists and engineers while encouraging black youths to pursue careers in science. The Museum set three objectives for the "Black Achievers in Science" exhibition:

1. To present the achievements of historical and contemporary black scientists and engineers.
2. To increase public understanding of how institutions and social attitudes and policies have influenced the careers of black scientists and engineers.
3. To make black youths aware of science and engineering as desirable careers, and of the steps necessary to attain them.

"Black Achievers in Science" emphasizes that scientists are "real" people, that scientific inquiry is challenging and rewarding, and that a career is built, not with one grand accomplishment, but through succeeding at a series of challenges over a lifetime.

The goal of the "Black Achievers in Science" Teachers Guide is to provide an independent resource to help teachers accomplish these objectives in their classrooms.

C A R E E R S

Career choices are no longer as easy as "following in your father's or mother's footsteps." There are many career options from which to choose. Now students' choices range from computer graphics architect to biological engineer with thousands of jobs in between. It is important, at the fifth and sixth grade level, to begin informing students of the many career options from which they may choose. Also to be prepared for any career, they must pursue a well rounded education. This means taking math and science courses.

Today, high school students can choose their curriculum. With such freedom, many students opt for non-technical classes. If students in fifth and sixth grade are aware of the enormous variety of career possibilities and are encouraged to take math and science courses, they will be better prepared for the decisions they make in high school and the years to follow.

Listed below are suggested high school courses needed for a career in a technical field. We do not intend, however, to imply that elementary students must have a career path and area of study already decided. These courses also promote a well-rounded education for any career.

MATH COURSES
- Algebra I
- Algebra II
- Geometry
- Trigonometry
- Calculus
- Computer programming

SCIENCE COURSES
- Biology
- Chemistry
- Physics
- Advanced Placement course in student's favorite science field

FOREIGN LANGUAGE COURSES
- 2 years of a foreign language preferably German, Latin or Russian

ENGLISH
- Composition
- Literature
- Speech

Students should consult the *Occupational Outlook Handbook* which provides a listing and brief description of thousands of careers. It also gives information about areas of study to prepare for a career in that field. This book is available at most schools and libraries.

HOW TO USE THIS GUIDE

In this guide, 16 historical and contemporary black scientists and engineers are highlighted as role models. Four scientists are represented in each of four technical fields: life sciences, physical sciences, mathematics and computer science, and engineering. Both men and women are included from academia, industry, and government.

The scientists' biographies include information about their educational background, professional achievements, and attitude towards their work. These biographies tell how the "Black Achievers" overcame tough challenges. You can easily relate these role models to the student and the "Black Achiever." Qualities such as family background, determination, curiosity, and other interests the role model has, can be highlighted. It is important to note that these role models are presented to help students understand the need for science and math classes and guide the student through a career in science.

When reading the biographies, you will begin to notice that two ideas are consistent among the 16 scientists: curiosity and determination. Each of them possesses these qualities. Curiosity is central to scientific inquiry, and determination is necessary for anyone to become established in a technical field.

Following each set of four biographies is a career path for the technical area represented in the biographies. These sections present information needed in planning for a career in science. Included in each career path are lists of the types of technical jobs which are available with increasing amounts of education.

As an aid in understanding the chronological ordering of the "Black Achievers," a timeline has been included which may be photocopied for your students. You will notice that the timeline begins with Benjamin Banneker and progresses to the present.

This booklet includes three resource listings. The first is a listing of professional organizations which offer information on specific technical fields and careers; the second is a listing of publications dealing with careers; the final list includes the publications used in producing this booklet.

"Black Achievers in Science" Teachers Guide can enhance many areas of study in the classroom. It can be used to teach a single unit or used throughout the year in conjunction with math, social studies, or science texts. Given the interdisciplinary nature of elementary grade textbooks, the 16 "Black Achievers" can be used during one grade level or across a number of grade levels. The pages of this guide may be photocopied for your students.

When studying an area of science related to the "Black Achievers" in the life sciences, you can discuss living organisms' growth, agriculture, plants, cells, genes, bacteria, disease, biochemistry, and animal and human behavior.

The physical sciences include a variety of topics such as chemistry, motion, planets, geology, the sun, metals, sound, light, and the atmosphere. A student interested in this field investigates the different properties and principles of these topics.

Mathematics not only includes addition, multiplication, subtraction, and division but also involves patterns and logic.

Finally, engineering focuses on answering questions about how to build things. Engineering encompasses designing bridges, medical equipment, automobiles, housewares, toys, and buildings.

ERNEST E. JUST
1883-1941

Developmental Biologist

Ernest Just faced many challenges before he achieved his dream. His father died when he was four years old. When Ernest was old enough, he had to help provide for his family. He worked on farms harvesting crops. Even though he had to spend many hours working to support his family, he was enthusiastic about his studies.

When Ernest finished high school, his mother told him to go north where he would have a better chance at furthering his education. His family was poor and could not afford to pay for his trip to New York, so he had to work for his fare.

Ernest realized that his education was not adequate to get him into college. He was told he would need four years of study. He decided to attend Kimball Union Academy. With only four weeks before starting at the Academy, Ernest had to earn enough money to pay the entrance fee. Working many hours he was able to earn the money.

While attending the Academy, Ernest studied as hard as he worked. At the Academy he was president of the debate society and editor of the school's newspaper. He finished the four-year program in three years and was ready to begin college.

Ernest attended Dartmouth College, however, he did not like the school until he enrolled in a biology class. In particular, he became interested in the study of the cell. Ernest specialized in biology and graduated from Dartmouth with special honors.

Ernest went on to Howard University to teach. Five years later he became the head of the Biology Department. He was also a member of the University's School of Medicine and head of the Department of Physiology. He encouraged black students at Howard University to enter the medical field because there was a great need for doctors in black communities.

Throughout the years Ernest spent at Howard University, he also was working on his doctoral degree at the University of Chicago. In 1916, he received his Ph.D. in zoology.

Ernest Just's greatest success was his challenge of a widely accepted theory about cells. The theory states that the entire cell is dependent upon the nucleus for survival. This theory did not make sense to him. He conducted many years of research at the Marine Biological Laboratory, Woods Hole, Massachusetts, studying the relationships between the different parts of a cell. Today cell research is based on his theories and techniques.

Ernest Just loved learning and discovering answers for himself. He did not accept what others said without questioning. If it did not make sense to him, he figured out what did. It is this independent thinking that made him a good scientist and the first black American to be accepted into the science community.

---

1. What special challenges did Ernest Just have to overcome in order to achieve his goal?
2. What subjects did he teach at Howard University? How were his efforts directed toward assisting the black community at large?
3. What recent developments have taken place in his specialty?
4. Map out the steps Ernest took in order to become a famous scientist.

HARVEY M. PICKRUM
1943-

Microbiologist

"You never know what you are capable of doing until you get out there and try. I am not saying be hard-headed and stubborn, but people don't always give you the best advice."

Harvey Pickrum's parents took care of a YMCA camp. During his youth, he participated in and enjoyed the many nature courses which the camp offered. It is here that his interest in the protection of the environment and wildlife began. This was his first experience with science.

Unfortunately, the science courses offered in his high school weren't very good, making it difficult for him to pursue his interests in science.

Harvey Pickrum went to college because someone bet him $100 that he couldn't finish the first year. Harvey was a proud person and was determined to prove that person wrong.

It wasn't until attending college that he learned of careers in microbiology, chemistry, and zoology. Because of his strong interest in science and the lack of courses available in high school, Harvey took more science courses than were necessary. He was excited about the things he learned in these classes. Several years later the administrators at Ohio State University told Harvey that he had taken 300 hours of courses and only needed a total of 190 hours to graduate. He looked back at all of the courses he had taken and noticed he took more microbiology courses than any others. He graduated in 1970 with a B.S. in microbiology.

Harvey was planning to work for the U.S. Postal Service as a mailman. With a family to support, he did not see how he could go on for advanced degrees. At the urging of one of his professors, Harvey decided to continue on at Ohio State University for his master's degree and Ph.D. in microbiology. It was while he was working on his master's degree that he became interested in the effects bacteria have on our environment.

Harvey Pickrum currently works for the Procter & Gamble Co. as a staff scientist. He has worked with research teams to discover the causes of diaper rash, toxic shock syndrome, and dental problems.

Harvey Pickrum feels that it is important for him to spend some of his free time developing and sponsoring programs directed toward black youths. He has organized a ski club in Cincinnati and is involved with the YMCA Youth Black Achievers Program.

Throughout his many years of school and his scientific career, it was his need to understand "why" that kept him interested in research. Not only is it his curiosity that is important in Harvey's life but also his pride. Pride got him into college and determination helped him see it through to the end.

---

1. How did Harvey Pickrum's early experience prepare him for a career in science?
2. What factors influenced his choice of career?
3. What type of problems does a microbiologist investigate?
4. How does Harvey Pickrum's work for Procter & Gamble relate to his interest in nature and the environment?

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GEORGE W. CARVER
1864-1943

Agricultural Scientist

"Education is the key to unlock the golden door of freedom to our people."

George Washington Carver and his older brother were adopted by Moses and Sue Carver when he was an infant. As a child growing up on his family's farm, he spent many hours investigating plants. George did not know how to read, write, or do math. But, he always hoped to learn those skills and someday earn a college degree.

At the age of 10 he left home and went to a neighboring town where there was a school—he loved learning. Soon, though, he realized that he had learned all that was available to him at the school. He also knew that there were more things to be discovered, so he decided to leave and continue his formal education elsewhere. He attended high school in Kansas and, soon after, applied to Highland University where he was accepted and received a scholarship. Unfortunately, when he arrived at the college to begin classes he was not allowed to attend because he was black. He left there very discouraged and did not try to get into another university for two years.

Finally, he applied to, and was accepted at, Simpson College. George continued to work to support himself while attending college. Because of his early interest in nature and plants, George decided to study agriculture. After several semesters at Simpson College, his teachers suggested that he transfer to Iowa State College of Agriculture and Mechanical Arts because they had a better program in agriculture. George followed their advice. He received a college degree from Iowa State and was offered a teaching job in the Agriculture Department at the college. While teaching at Iowa State, he began work on his master's degree.

While George Carver was teaching at Iowa State, Booker T. Washington, President of Tuskegee Institute, wrote a letter asking him to join the faculty of the Institute. Honored by the invitation, he accepted.

Not only did he work very hard as a teacher and in improving his department, he spent most of his time trying to discover why the soil in the southern United States had stopped producing good crops. It was through his extensive research of the peanut and sweet potato that the idea of "crop rotation" was developed. He discovered that some plants remove important nutrients from the soil while others can replace them. By planting different crops every two or three years a farmer can keep the soil fertile. What he discovered has helped improve farming around the world. His greatest achievement is considered to be his invention of over 300 commercial uses for the peanut. Through his work, the peanut became a profitable crop for farmers.

George Washington Carver faced many challenges in his attempt to achieve his dream, and it was his determination that made his attempt successful. It was also a result of his determination that he was able to make the most of what he had. The lack of equipment at Tuskegee did not keep him from making his many important agricultural discoveries.

---

1. What special challenges did George Carver face in attempting to achieve his educational goals?

2. How did George Carver's efforts affect the quality of life for black people in the southern states?

3. George Carver is noted for developing over 300 different commercial products that are made from peanuts. Name ten. What other agricultural products did he investigate?

4. George Carver's work helped farmers. Can you think of other people who benefited from his work?

PATRICIA S. COWINGS
1948–

Psychophysiologist

"Don't give up. No matter how bad or scary it gets. Not even when you ask yourself, 'what am I doing here?'"

Around the age of 11 years, Patricia Cowings became interested in space. She spent much of her free time reading one science fiction book after another. It was about the same time that she began to wonder what people could achieve and how they could change through learning. Questions such as "Could someone make himself feel better by learning to control what makes him sick?" are of interest to her.

Patricia Cowings' family includes three brothers and five uncles. Because of her family structure, she had the impression that women were not equal to men. She felt she had something to prove to herself and her family which gave her the determination she needed.

Challenges for Patricia didn't appear so much in her early education as they did in college. She was faced with breaking the barriers for blacks and women wanting to enter science.

While in college, she heard of a professor who was teaching people how to control their brain waves. This was a new idea, and it tied into her interest. She persuaded the professor to let her work with him. Now new questions developed from old ones: "What happens to involuntary muscles immediately before someone is sick?" and "How can this be controlled so the person won't be sick?"

Patricia enjoyed scientific research, so after she graduated with her bachelor's degree she went on for her master's degree and Ph.D. at the University of California, Davis. Her major was in psychology, yet she was intrigued by the field of engineering. She decided to enroll in a course offered by the Engineering Department. This was daring because the field was dominated by men. The focus of the course was to design a feature of a spacecraft that would be helpful to the astronauts. Her project dealt with motion sickness.

Patricia Cowings works for NASA training astronauts to deal with motion sickness. She also is researching and developing exercises that help astronauts maintain their muscle strength while in space.

It was Patricia Cowings' determination to succeed that allowed her to work with some of the most respected scientists across the country. This quality also helped her break the barriers of gender and color. Determination was important to her personal and scientific achievements.

1. What educational background is necessary for a career in psychology?
2. What do brainwaves and biorhythms have to do with Patricia Cowings' work for NASA?
3. Engineering is considered a non-traditional field for a woman. What problems do you think Patricia Cowings encountered? How would you overcome them?
4. How do long periods of weightlessness affect astronauts physically and psychologically?

CAREER PATHS IN LIFE SCIENCES

STARTING OUT

HOW DOES A BABY DEVELOP?

Go see a museum display or find a book in the library on the subject.

HOW DO PLANTS GROW IN CRACKS IN THE SIDEWALK?

Find some plants growing in the sidewalk. How can they grow there? Can you find any similar plants or leaves from trees nearby?

CURIOSITY

MAKE GOOD CHOICES

. . . make your dreams come true

set aside a time for studying

do a Science Fair project

apply to college as soon as you could

DREAM BIG

GOOD PLANS HELP YOUR CAREER

1

Take these important courses in high school:

Math
Algebra I
Algebra II
Geometry
Trigonometry
Calculus
Computer Programming

Foreign Language
2 years of a foreign language, preferably German, Russian, Latin, or French

Science
Biology
Chemistry
Physics
Advance Placement (AP) course in your favorite science

English
Literature
Composition
Speech

2

Take all of the important exams that colleges require:

SAT and ACT
Take the **Scholastic Aptitude Test (SAT)**, the **American College Test (ACT)**, or both in your junior or senior year. Colleges use the results of these important exams along with your grades to judge your application.

PSAT
In your junior year, take the **Preliminary Scholastic Aptitude Test (PSAT)**. It will give you practice for taking the SAT.

High scores on the PSAT and SAT, plus a high grade average, may allow you to win a National Merit Scholarship (for outstanding high school students), or a National Achievement Scholarship (especially for outstanding black students).

3

Make special arrangements with a community college if your high school doesn't offer some courses.

Visit a college campus, and find out if they have any special summer or pre-college programs.

Study hard for good grades! Earn your high school diploma.

FULFILLING A DREAM

BUILDING YOUR CAREER IN THE LIFE SCIENCES

HIGH SCHOOL

LABORATORY ASSISTANT
does daily work needed for professors' experiments.

GARDENER
takes care of plants grown in campus greenhouse, botanical garden, or nursery.

NURSING ASSISTANT
gives basic bedside care in hospitals and nursing homes such as feeding and moving patients.

FORESTRY AIDE
helps foresters in taking care of forests and preventing fires.

WASTEWATER TREATMENT PLANT OPERATOR
runs equipment at sewage treatment plants.

SOCIAL SERVICE AIDE
asks applicants questions and tells them about social services.

PHYSICAL THERAPY AIDE
works for physical therapist who treats patients with muscle problems.

DENTAL LAB TECHNICIAN
makes dental fittings for a dentist to place in patients' mouths.

TECHNICAL SCHOOL, COMMUNITY COLLEGE, OR ARMED FORCES

MEDICAL LABORATORY TECHNICIAN
performs daily laboratory work and medical tests.

LICENSED PRACTICAL NURSE
provides basic care to patients in hospitals and nursing homes, such as giving shots, giving medications by mouth, and changing bandages.

REGISTERED NURSE
watches patients' conditions, writes down detailed reports, gives medications, and works side by side with doctors.

PHYSICIAN'S ASSISTANT
examines patients, asks them about illnesses, and gives medications to them in doctors' offices.

EMERGENCY MEDICAL TECHNICIAN
decides how badly hurt patients are, helps them right away, and takes them to hospitals.

FISHERY AIDE
cares for fishes raised in hatcheries and helps scientists do research on fishes in lakes and streams.

SOCIAL SERVICE TECHNICIAN
finds help for applicants, and gathers information for research studies.

BACHELOR'S DEGREE

4 YEARS OF COLLEGE

MIDDLE SCHOOL OR HIGH SCHOOL TEACHER
instructs students in biology.

NURSE PRACTITIONER
takes special training in one area of nursing to direct patient care and consult with doctors.

MEDICAL TECHNOLOGIST
makes sure that tests are performed correctly in hospital labs.

PHYSICAL THERAPIST
treats patients who have muscular problems so that they can walk and move freely once more.

PHARMACIST
prepares and sells prescription medications.

BOTANIST
studies plants and where and how they live.

AGRONOMIST
studies plants and the soil to find ways to improve the soil, grow better plants, and harvest more crops.

RESEARCH ASSISTANT
carries out experiments for a research biologist.

SOCIAL WORKER
helps individuals and groups improve their ability to function in society.

ZOO TECHNICIAN
cares for zoo animals and helps the zoo staff.

MASTER'S DEGREE

2 TO 3 YEARS BEYOND COLLEGE

HIGH SCHOOL OR JR. COLLEGE TEACHER
instructs students in biology.

PHYSICAL THERAPIST
treats patients who have muscular problems so that they can walk and move freely once more.

REGISTERED NURSE
runs a nursing home, does research, or teaches in a certain area of nursing.

HOSPITAL ADMINISTRATOR
manages staff and operations of hospital.

PSYCHIATRIC SOCIAL WORKER
helps psychiatrists by learning about the lives of patients' from them and their families.

MICROBIOLOGIST
identifies bacteria and studies how and where they live.

BIOCHEMIST
studies the chemical processes that keep living things alive.

ZOOLOGIST
studies animals and where and how they live.

Ph.D. OR PROFESSIONAL DEGREE

4 TO 7 YEARS BEYOND COLLEGE

UNIVERSITY

PROFESSOR
teaches biology to students and does research.

ADMINISTRATOR
manages university and department professors and the courses they teach.

RESEARCH SCIENTIST
does experiments for research projects.

INDUSTRY

RESEARCH SCIENTIST
does experiments for research projects.

ADMINISTRATOR
manages staff of scientists and their research projects.

HOSPITAL/CLINIC

PHYSICIAN
decides how to care for patients and treats them.

DENTIST
decides how to care for dental patients and treats them.

PSYCHOLOGIST
decides how to care for patients with mental or emotional problems and treats them.

REGISTERED NURSE
directs a 4-year nursing program, teaches students in master's programs, or does research.

GEORGE R. CARRUTHERS
1939-

Astrophysicist

"You have to start preparing early. Take all the science and math courses offered. Emphasize the basics."

As a child, George Carruthers was interested in the idea of space flight. His interest in space came from his enjoyment of science fiction books, especially books about Buck Rogers. George also spent many hours reading his father's old textbooks about astronomy. His father encouraged his interest in science and engineering. Eventually, he was able to combine all of his interests—space flight, astronomy, and engineering—into a career.

At the time George was in grade school, around the 1950s, people (including astronomers) thought that the possibility of space flight was silly and would not become a reality. Because of his interest in astronomy and space flight, he spent most of his weekends at the planetarium. It was astronomers at the planetarium who discouraged his ideas and caused George's doubts about a career in astronomy.

When he was about 12 years old, his father died. This made it difficult for George and his family. Money was very scarce.

Just before entering college, George decided on engineering over astronomy. He chose engineering because he felt he could contribute more by developing new techniques that would advance science rather than trying to follow what was already set by astronomy.

Going to college was difficult for George because there wasn't enough money, however, he was determined. Between scholarships and working he earned enough money to go to college. He received a bachelor's degree in Aeronautical Engineering from the University of Illinois in 1961. He continued on at the University of Illinois and received a master's degree in nuclear engineering in 1962, and a Ph.D. in aeronautical and astronautical engineering in 1964.

George Carruthers' list of achievements includes developing space telescopes for the Apollo 16 mission, a rocket experiment in 1970 which resulted in the first detection of molecular hydrogen in space, the study of gases released from comets, and the development of instrumentation for sounding rocket experiments. He strives to produce highly sensitive detectors for ultraviolet, x-ray, and infrared radiation.

George Carruthers had big dreams, and even though others discouraged him and thought his ideas were silly, he kept dreaming. He didn't stop there, he turned his dreams into reality. He went to college and followed a path that he felt would help him achieve his dream.

---

1. How did George Carruthers' early interest in science fiction affect his choice of a career?
2. Name two of his professional accomplishments.
3. What type of educational background is necessary for a career in astrophysics?
4. What advice does George Carruthers offer to young people interested in pursuing a career in science?

PERCY L. JULIAN
1899 - 1975

Organic Chemist

"The Negro scientist now need neither starve nor be condemned to a frustrating intellectual ghetto if he chooses pure science as a career, and one can see a promising future for this fresh and uninhibited imaginative power."

Percy Julian was always fascinated with the sciences, especially chemistry. As a child he would sneak over to the nearby high school and watch what was going on in the chemistry class. But because of his color, he was kept at a distance from "doing" science. He went to a grade school for blacks which had no laboratory.

His father was a proud man and always wanted more for his children. When Percy got 80% on a test at school, his father urged him to get 100% instead. This taught him not to settle for anything less than perfection.

Percy had to go away from home in order to attend high school since there wasn't a school for blacks nearby. He studied hard and his grades were good. They were good enough to get him a scholarship to college.

Even though his grades were good in high school his teachers at DePauw University in Indiana, thought that Percy had some catching up to do. He was required to enroll in remedial classes plus a full load of college-level courses. He also worked in a fraternity house in order to support himself. Despite this heavy work and class load, he was able to graduate in four years. He graduated with honors and was the first in his class.

Percy faced disappointment just after he graduated from college. Usually, the students who attended DePauw University are recommended for scholarships to continue their education. He watched all of his friends receive these scholarships while he waited patiently for his. A scholarship for Percy never came even though he was the top in his class. One of his teachers arranged an interview with Fisk University. He was offered a teaching position at the University. It wasn't until two years later that Percy was given a scholarship to one of the best universities in the country, Harvard. Percy finished his master's degree within a year. While teaching at Howard University, he received a grant to study abroad. Two years later he finished his doctoral program at the University of Vienna.

Percy Julian is best known for his achievements in chemistry. He produced in the laboratory chemicals which earlier were only available from nature. He extracted a chemical which he used to make sex hormones. These are used to treat some forms of cancer and pregnancy disorders. He is also well known for making cortisone, in the laboratory, which relieves arthritis. His research made these chemicals more widely available and less expensive to manufacture.

What is important about Percy Julian is his determination. When he didn't receive a scholarship to continue his education, he didn't quit. He endured setbacks, but he didn't give up. He went on to found his own company and make some very important pioneering discoveries.

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1. What personal challenges did Percy Julian face in attempting to pursue a scientific career?
2. How did he complete his education after he failed to receive the scholarship he expected?
3. Percy Julian is noted for his success in producing several important chemicals artificially. Name two and indicate why they are important.
4. How did he describe career opportunities for blacks in the pure science? Do you agree with his comment?

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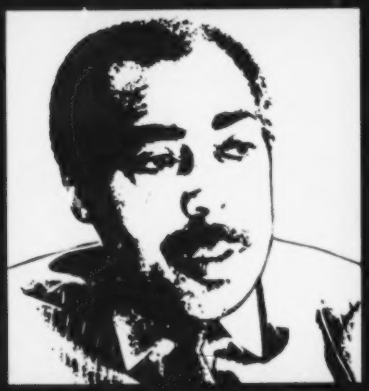

WALTER E. MASSEY
1938-

Theoretical Physicist

"Opportunities are fantastic in every area of science. Not only in terms of personal satisfaction, but practically all areas of economic growth are based on developments in science and technology. As a scientist you can enjoy yourself and also contribute to society."

At the age of 14, Walter Massey had an interest in music. He was a very good saxophone player who helped set up his high school marching band and also started his own rock band. But, music wasn't the only thing that interested him. He enjoyed reading and read many books, including classics like *Moby Dick* and *Treasure Island*. He also enjoyed math.

When Walter was in the tenth grade his life drastically changed. He decided to leave Hattiesburg, Mississippi, and go to Morehouse College in Atlanta. The confidence that Walter had when he was in high school suddenly disappeared. His confidence was quickly restored, however, when taking the placement exams, he scored among the top five in his class.

It was in college that Walter took his first chemistry course. He realized that math was heavily involved in chemistry. It was through this chemistry course that he was able to see how math had an impact on our everyday lives.

He also became interested in physics classes while he was at college. What he loved about physics was the challenge that it presented. He was interested in understanding a problem and trying to predict how something would react under different circumstances.

In 1958, he graduated with a degree in physics and math. He went on to continue his education and in 1966 graduated from Washington University with a master's and Ph.D. in physics. Walter's doctoral research was an investigation of the properties of liquid helium, a field that today we call "superconductivity."

Walter Massey is currently the Vice President for Research for Argonne National Laboratory and Professor of Physics at the University of Chicago. Throughout his scientific career, he has served on many community affairs organizations. In 1982, he chaired the Chicago Mayor's Task Force of High Technology Development. He is a member of the Illinois Governor's Commission on Science and Technology and a member of the Board of Trustees for Brown University and the Rand Corporation. He also is president elect of the American Association for the Advancement of Science.

When he was younger, Walter Massey developed a sense of curiosity. He was interested in understanding a problem and prediction. He didn't like the answers given to him, instead he worked to figure them out by himself. This curiosity and independent thinking is an important part of his character.

1. What educational background is necessary for a career in physics?
2. Name two of Walter Massey's professional accomplishments.
3. Why does he feel young people should pursue careers in science and technology?
4. What kinds of things do you enjoy doing? Could these be possibilities for future careers? Give examples.

WARREN M. WASHINGTON

1936-

Meteorologist

"You don't have to be a 'straight-A' student. There will always be some better student in the class, but that person may not turn out to be the better scientist. Maybe you will be more creative."

Warren Washington became interested in the area of science when he was in elementary school. He liked to read about science and scientists. Einstein and physics were two of his favorite topics.

When he was in high school, he became fascinated by chemistry. His high school chemistry teacher got students interested by challenging them to figure out the answers. Warren's project, for this class, was to figure out why corn was yellow. He enjoyed the challenge of discovering something on his own.

Warren had many interests in high school. He loved outdoor sports and being with his friends. He had a sense of discipline and organized his time studying and his time with friends. This sense of discipline came from his parents. They encouraged him to study hard and achieve.

Warren knew he wanted to continue in science when he entered college, contrary to the advice of his high school counselor. He graduated from Oregon State University with a degree in physics. The summer after he graduated he worked at Stanford as a mathematician solving problems dealing with the atmosphere. After the summer, he continued his education in physics at Oregon State University. Before he left Stanford he asked one of the scientists if they knew of any colleges that had a combined program in math, computers, and science. The scientist suggested Penn State University. When Warren finished his master's degree at Oregon State University he applied and soon after was accepted to Penn State University. He graduated from Penn State with a Ph.D. in atmospheric sciences and went to work for the National Center for Atmospheric Research in Colorado.

In 1972, Warren Washington was appointed by President Carter to serve on the National Advisory Committee on Oceans and Atmosphere. This committee guided the Executive Branch of the government and Congress on issues that related to the atmosphere and the oceans.

Warren Washington is currently the Director of the Climate and Global Dynamics Division at the National Center for Atmospheric Research. He has built computer models of the atmosphere and oceans in order to study the changes they have undergone and predict what might happen in the future. He is interested in the effects of pollution and the cutting down of forests on the earth and its atmosphere.

Warren Washington's determination and independent thinking helped him become an important scientist. He followed his dream even though his high school counselor tried to discourage him from continuing in physics. He was challenged to figure out the answers through his own abilities. These are important qualities that make him an achiever.

---

1. How has Warren Washington's career allowed him to combine his interests in math, computers, and science?
2. What educational background is needed for a career in atmospheric science?
3. What advice does he offer young people interested in a scientific or technical career?
4. List the many people and jobs that benefit from Warren Washington's work.

CAREER PATHS IN PHYSICAL SCIENCE

STARTING OUT

WHY DOES HALLEY'S COMET RETURN TO EARTH EVERY 76 YEARS?

Go to a planetarium or a museum to learn about comets, or find a book in the library on the subject. What is a comet made of?

WHAT KINDS OF METAL THINGS RUST?

Let a wet steel-wool pad set for a week or longer. Observe the rusted strands of steel. Compare the rusted pad with other rusty things.

CURIOSITY

MAKE GOOD CHOICES

. . . make your dreams come true

. . . set aside a time for studying

. . . do a Science Fair project

. . . apply to college as soon as you could

DREAM BIG

GOOD PLANS HELP YOUR CAREER

1

Take these important courses in high school:

Math
Algebra I
Algebra II
Geometry
Trigonometry
Calculus
Computer Programming

Science
Biology
Chemistry
Physics
Advance Placement (AP) course in your favorite science

Foreign Language
2 years of a foreign language, preferably German, Russian, Latin, or French

English
Literature
Composition
Speech

2

Take all of the important exams that colleges require:

SAT and ACT
Take the **Scholastic Aptitude Test (SAT)**, the **American College Test (ACT)**, or both in your junior or senior year. Colleges use the results of these important exams along with your grades to judge your application.

PSAT
In your junior year, take the **Preliminary Scholastic Aptitude Test (PSAT)**. It will give you practice for taking the SAT.

High scores on the PSAT and SAT, plus a high grade average, may allow you to win a National Merit Scholarship (for outstanding high school students), or a National Achievement Scholarship (especially for outstanding black students).

3

Make special arrangements with a community college if your high school doesn't offer some courses.

Visit a college campus, and find out if they have any special summer or pre-college programs.

Study hard for good grades! Earn your high school diploma.

FULFILLING A DREAM

BUILDING YOUR CAREER IN THE PHYSICAL SCIENCES

HIGH SCHOOL

RODMAN
helps instrumentman on surveying team to determine distances and boundaries between pieces of land.

CHEMICAL TECHNICIAN
carries out laboratory experiments for chemists.

CARTOGRAPHER
makes maps of land features.

LABORATORY ASSISTANT
does daily work on a scientist's experiments.

OPERATOR
works in a chemical factory.

TECHNICAL SCHOOL, COMMUNITY COLLEGE, OR ARMED FORCES

LAB TECHNICIAN
carries out laboratory experiments for researchers.

INSTRUMENTATION TECHNICIAN
keeps instruments in laboratory working well.

SOIL CONSERVATION AIDE
helps soil scientists study how good soils are and how to keep them from washing away.

INSTRUMENTMAN
uses surveying equipment to find boundaries and features on pieces of land.

CARTOGRAPHER
makes maps of land features.

BACHELOR'S DEGREE

4 YEARS OF COLLEGE

MIDDLE SCHOOL OR HIGH SCHOOL TEACHER
instructs students in chemistry, physics, or earth sciences.

NUCLEAR MEDICAL TECHNICIAN
uses large hospital equipment to scan patients' body organs and find disease.

SOIL SCIENTIST
studies soils, how to improve them, and how to keep them from washing away.

METEOROLOGIST
studies weather patterns and models of them on computer to predict day-to-day weather and big storms.

RESEARCH TECHNICIAN
runs experiments in laboratories for researchers.

PLANETARIUM ASSISTANT
helps prepare educational shows and exhibits about stars and planets.

CHEMIST
runs experiments to learn about how chemicals react together and the products they form.

TECHNICAL SALESPERSON
sells chemicals and equipment.

TECHNICAL SUPPORT REPRESENTATIVE
gives information to salespeople and customers.

MASTER'S DEGREE

2 TO 3 YEARS BEYOND COLLEGE

GEOLOGIST
studies the Earth's structure and past, and finds oil and minerals within layers of rock.

HIGH SCHOOL OR COMMUNITY COLLEGE TEACHER
instructs students in chemistry, physics, or earth sciences.

RESEARCH ASSISTANT
runs experiments in laboratory for research projects.

CHEMIST
runs experiments to learn about how chemicals react together and the products they form.

PHYSICIST
studies matter, energy, and the laws that govern how they behave.

BIOCHEMIST
studies the chemical processes that keep living things alive.

Ph.D.

4 TO 7 YEARS BEYOND COLLEGE

UNIVERSITY

RESEARCH SCIENTIST
conducts experiments or works out theories for research projects.

PROFESSOR
teaches students in chemistry, physics, astronomy, geology, or meteorology and does research.

ADMINISTRATOR
manages university and department professors and the courses they teach.

ASTRONOMER
studies the sun, planets, stars, galaxies, and the origin of the universe.

INDUSTRY

RESEARCH SCIENTIST
conducts experiments or works out theories for research projects.

ADMINISTRATOR
manages other scientists and their research projects.

GOVERNMENT

RESEARCH SCIENTIST
conducts experiments or works out theories for research projects.

ADMINISTRATOR
manages other scientists and their research projects.

ASTRONOMER
studies the sun, planets, stars, galaxies, and the origin of the universe.

FERN Y. HUNT
1948–

Applied Mathematician

"Be a little more self-confident. Be patient with yourself. Allow yourself the time."

When Fern Hunt was in the ninth grade she had taken a science course and found out that she really enjoyed it. Her science teacher was black and a very good teacher. She provided a good role model for Fern.

In the tenth grade, one of her teachers recommended that she attend a weekend science course sponsored by Columbia University. Fern was so excited about this course that she took another one over the summer and also signed up for a weekend course offered in math. It was this course that turned her fear of math into love.

Fern received a good education from the Bronx High School for Science in New York. This was a special high school for students who were interested in science. While growing up in New York, she had to face a lot of teasing because she was black. She found that her biggest challenge was overcoming the fear of how other people would react to her.

It was during college at Bryn Mawr, that she began to see math as a possible field of study. She was inspired to go into math after reading *Men of Mathematics*, and a biography about Sonya Kovaleskaya, a female mathematician.

Fern had many interests outside of math. She loved to read, watch television, and play the piano and organ. She felt that all of these have helped to build her imagination which is very important to a scientist.

Fern Hunt graduated with a master's degree and a Ph.D. in math from New York University. Her studies focused on what is called applied mathematics—the study of mathematical calculations in everyday life. In previous years she studied math as it related to biology. For example, she was able to figure out the chance that a certain trait would appear such as brown eyes versus blue eyes. When Fern was working on her Ph.D., she changed her focus a little and became interested in patterns.

Currently Fern Hunt is a professor at Howard University. She describes herself as a researcher who loves to teach. Through her research she has advanced theories and their applications. Through teaching she has opened minds to a new world—math.

It is Fern Hunt's love of learning that is so important to remember. It is this desire to learn that she gives to her students. She felt very lucky that she received a good high school education. At the time she was going through high school she didn't take the quality of the school for granted. Instead, she made the most of a good opportunity.

---

1. What books did Fern Hunt read that helped influence her choice of a career?
2. Describe her leisure time activities.
3. Many natural objects display regular geometric shapes and can be described using mathematics. Name two and describe the math involved.
4. What job opportunities are available to people with a degree in mathematics?

DAVID H. BLACKWELL
1919–

Statistician

"Go into mathematics simply because you like it."

As a young child, David Blackwell was fascinated by games. The game that interested him the most was checkers. He would ask adults questions like, "Could the first player always win in the game of checkers?" and "Which positions on the board would produce a win?" He realized that these questions could be answered by math. It was the never-ending questioning and love of games that eventually lead to a career in math.

Through grade school and high school, David had several teachers that made math exciting for him. In high school, geometry was of special interest to him. It was at this time that he began to find the answers to his questions. Other than math, he was never enthusiastic about school. This changed, though, when he entered college.

David graduated high school at age 16 and immediately enrolled at the University of Illinois. Right from the beginning, he knew he wanted to be a teacher. At first, he wanted to teach grade school; later this changed to high school or college.

During his first year in college he found out that his father was borrowing money in order to put him through college. Since David was going to college during the Depression, it was very hard to find a job. He was determined to support himself because he didn't want his father to borrow any more money for his schooling. He worked many different jobs like waiting tables and cleaning laboratories.

Within three years, David finished college and went on to further his education. It was during graduate school that his teachers were most influential and guided him into an area of math known as statistics. Statistics calculates the chance of something happening. For example, if you flipped a coin 20 times, what are the chances it will land "heads up" five times out of the 20? In 1938 he received a master's degree and in 1939, his Ph.D.

After finishing graduate school, he went on to teach college. From 1944 to 1954 he taught at Howard University. In 1955 he became professor of statistics at the University of California at Berkeley and has been a member of the faculty ever since. He enjoys teaching because of the pleasure that comes from sharing an idea with someone.

All through college, graduate school, and teaching, David Blackwell's questions advanced the current theories in math. He rarely accepted an answer without questioning and carefully looking at it. It is this continual questioning and wanting to understand that is important to his career.

---

1. What personal challenges did David Blackwell overcome in order to achieve his educational goals?

2. Use statistical techniques to analyze the frequency of letters in the English language. How do game manufacturers make use of these frequencies?

3. Try rolling two dice at a time. Use a chart to keep track of your data and plot your results on a graph.

4. What is you favorite game? What kinds of mathematical questions can be asked about this game?

MARC R. HANNAH
1956-

Computer Scientist

"Keep your eyes open for opportunities, and be willing to take some risks early in your career. Have the confidence to realize that if something doesn't work, there is always another job."

Marc Hannah didn't become interested in math, physics, and computers until he was in high school. During his senior year, his brother got him interested in electronics. Eventually this combination of interests led to a career in computer science.

Marc graduated from Kenwood Academy in Chicago. Two of his favorite subjects in high school were physics and math. In his senior year he took a computer programming course. This helped him determine his interest in computers.

Marc went to Illinois Institute of Technology in Chicago. In 1977 he graduated with a degree in electrical engineering. The area of study that he decided on drew heavily on his math and science background that he built in high school. During the summer of 1977, he worked for AT&T Bell Laboratories. His project at the laboratory was to design computer graphics.

Marc went on to Stanford for his master's degree and Ph.D. He transferred to another Bell Laboratories facility so he could continue his research in computer graphics while attending graduate school. In 1985, he graduated with a Ph.D. in electrical engineering from Stanford. It took eight years for him to complete his degree because he switched the focus of his studies and he took a year off to start his own business. He cofounded Silicon Graphics with one of his own professors, Jim Clark.

Marc currently is the principal scientist for his company—Silicon Graphics, Inc. He is a computer architect who designs programs that create realistic looking 3-D images for many engineering uses including flight simulators and commercials.

Marc Hannah made the most of his opportunities. Working at Bell Laboratories gave him business experience. While working on his Ph.D. he put his knowledge to use and began his own company. He used all of the opportunities he had.

---

1. What factors influenced Marc Hannah's career choice in computer science?
2. Study the "help wanted" section of a newspaper. Make a list of all the jobs related to computers. Share your list with your class.
3. What opportunities are available related to your favorite subjects or hobbies?
4. If you could create a company what would it be? What would be your job in the company?

BENJAMIN BANNEKER
1731 - 1806

Mathematician and Astronomer

". . . the calculations were made more for the sake of gratifying the curiosity of the public than for any view of profit, as I suppose it to be the first attempt . . . in America by a person of my complection [sic]."

Benjamin Banneker was one of three children. He had two sisters. Benjamin's parents owned a 120-acre farm. The farm provided the necessities for daily living. Some of the crops they grew on the farm, tobacco and corn, were traded for other food items and clothing. He began attending a private school as a young man, but could not continue because he was needed on the farm.

Even though Benjamin could not continue school he kept learning. While he was working on the farm, he would make up mathematical puzzles in his mind and try to solve them. All along he was very interested in patterns and math. He spent most of his spare time reading whatever books he could find. Some of his favorite books were about math.

Benjamin had an excellent memory. By using his memory and math skills he built a striking clock, based on a pocket watch he saw. This clock was made so skillfully that it kept perfect time for 20 years. Amazingly, he had carved it entirely from wood.

His father died when Benjamin was 26 years old. At that time Benjamin inherited the family farm. It was difficult to find enough time to work the farm and keep up his study of math. Eventually he rented his land to other farmers.

Benjamin's interests turned towards astronomy. The study of the stars, planets, and the universe is dependent on math. For example, you can calculate when the next ten eclipses would occur by using a mathematical formula. He discovered that this type of information was important to farmers. He put this type of information in a book called an almanac. Calendars, which are calculated by mathematical formulas, and information on planets, stars, the moon and sun were included in his almanac.

Benjamin Banneker was a member of a team of engineers who designed the city of Washington, D.C. This was the first presidential appointment received by a black American. He helped change the mind of Thomas Jefferson that blacks are intellectually inferior. Benjamin sent the Secretary of State one of his almanacs. Thomas Jefferson was impressed by it.

What is important about Benjamin Banneker is that he would never quit. Even though he could not continue school, he kept learning. He challenged himself to think up and solve new mathematical problems. He put this to use as an adult by providing the country with important information printed in his almanac.

---

1. What does it mean to be "self-educated"? How does this term apply to Benjamin Banneker's career?

2. Could someone achieve all that he did today with Benjamin Banneker's level of education? What additional training would be needed?

3. Benjamin Banneker has been praised as an inventor, mathematician, surveyor, and astronomer. Select one of these areas to research and describe his accomplishments in detail.

4. What is an "almanac"? Discuss how his mathematical skills and astronomical studies combined to produce a series of these extremely useful publications.

CAREER PATHS IN MATHEMATICS

STARTING OUT

WHEN YOU FLIP A COIN, WILL YOU GET HEADS HALF OF THE TIME?

Flip a coin 4, 8, and 12 times. What results did you get? What do you think "a 50-50 chance" means?

WHY ARE CERTAIN SHAPES USED IN FLOOR TILE AND OTHERS NOT?

Look at different kinds of tile patterns on the floor at school. Draw what you see. Try to draw tile patterns with other kinds of shapes. What happens?

CURIOSITY

MAKE GOOD CHOICES

. . . make your dreams come true

. . . set aside a time for studying

. . . do a Science Fair project

. . . apply to college as soon as you could

DREAM BIG

GOOD PLANS HELP YOUR CAREER

1

Take these important courses in high school:

Math
Algebra I
Algebra II
Geometry
Trigonometry
Calculus
Computer Programming

Science
Biology
Chemistry
Physics
Advance Placement (AP) course in your favorite science

Foreign Language
2 years of a foreign language, preferably German, Russian, Latin, or French

English
Literature
Composition
Speech

2

Take all of the important exams that colleges require:

SAT and ACT
Take the **Scholastic Aptitude Test (SAT)**, the **American College Test (ACT)**, or both in your junior or senior year. Colleges use the results of these important exams along with your grades to judge your application.

PSAT
In your junior year, take the **Preliminary Scholastic Aptitude Test (PSAT)**. It will give you practice for taking the SAT.

High scores on the PSAT and SAT, plus a high grade average, may allow you to win a National Merit Scholarship (for outstanding high school students), or a National Achievement Scholarship (especially for outstanding black students).

3

Make special arrangements with a community college if your high school doesn't offer some courses.

Visit a college campus, and find out if they have any special summer or pre-college programs.

Study hard for good grades! Earn your high school diploma.

FULFILLING A DREAM

BUILDING YOUR CAREER IN MATHEMATICS AND COMPUTER SCIENCE

HIGH SCHOOL

RODMAN
helps instrumentman on surveying team to determine distances and boundaries between pieces of land.

COMPUTER OPERATOR
runs large computer equipment.

DATA ENTRY OPERATOR
enters data into computers.

BANK TELLER
puts in and takes out money for customers.

POLL TAKER
asks people a set of questions and records their answers.

TECHNICAL SCHOOL, COMMUNITY COLLEGE, OR ARMED FORCES

DRAFTSMAN
makes detailed drawings of engineering designs.

INSTRUMENTMAN
uses surveying equipment to find boundaries and features on pieces of land.

TELECOMMUNICATIONS TECHNICIAN
repairs equipment in telephone networks.

JOBS IN COMPUTERS

COMPUTER SERVICE TECHNICIAN
installs computers and keeps them running.

COMPUTER PROGRAMMER
writes and tests programs in languages used with computers.

COMPUTER SALESPERSON
sells computers and programs to run on them.

TECHNICAL SUPPORT REPRESENTATIVE
gives information to salespeople and customers.

BACHELOR'S DEGREE

4 YEARS OF COLLEGE

MIDDLE SCHOOL OR HIGH SCHOOL TEACHER
teaches students in mathematics, computers, and programming.

ACTUARY
figures out rates for insurance policies.

STATISTICIAN
gathers information in the form of numbers and figures out what it means.

JOBS IN FINANCE

ACCOUNTANT
manages the records of money handled in a business.

AUDITOR
checks to see if records of money are correct.

CREDIT ANALYST
studies statements of money in customers' accounts before giving loans.

FINANCIAL ANALYST
studies statements of money in accounts and predicts what will happen in business.

JOBS IN COMPUTERS

COMPUTER SCIENTIST
writes instructions for computers that allow them to operate.

INFORMATION SYSTEMS MANAGER
designs, sets up, and manages computer systems in businesses and other organizations.

SYSTEMS PROGRAMMER
solves problems when computers break down because their programs failed.

SYSTEMS ANALYST
studies how computers can improve how an organization runs.

COMPUTER SALESPERSON
sells computers and programs that run them.

TECHNICAL SUPPORT REPRESENTATIVE
gives information on computer products to salespeople and customers.

MASTER'S DEGREE

2 TO 3 YEARS BEYOND COLLEGE

Master's Degree

APPLIED MATHEMATICIAN
uses math to solve practical problems.

STATISTICIAN
gathers information in the form of numbers and figures out what it means.

HIGH SCHOOL OR JR. COLLEGE TEACHER
teaches students in mathematics, computers, and programming.

OPERATIONS RESEARCHER
states certain processes in mathematical terms in order to understand the processes better and improve them.

Ph.D.

4 TO 7 YEARS BEYOND COLLEGE

INDUSTRY

RESEARCH MATHEMATICIAN
studies and learns new things about math and numbers.

RESEARCH STATISTICIAN
figures out new ways to understand information in the form of numbers.

ADMINISTRATOR
manages staff doing mathematics research.

UNIVERSITY

RESEARCH MATHEMATICIAN
studies and learns new things about math and numbers.

RESEARCH STATISTICIAN
figures out new ways to understand information in the form of numbers.

ADMINISTRATOR
manages university and department professors and the courses they teach.

PROFESSOR
teaches math to college students and does research.

GOVERNMENT

RESEARCH MATHEMATICIAN
studies and learns new things about math and numbers.

RESEARCH STATISTICIAN
figures out new ways to understand information in the form of numbers.

ADMINISTRATOR
manages other mathematicians and research projects.

LEWIS H. LATIMER
1848–1928

Draftsman, Inventor, and Engineer

Lewis Latimer was the son of a slave who escaped from Virginia and made his way to Boston. He was one of four children in the Latimer family. While Lewis was going to grade school he worked a few hours each afternoon in his father's barber shop. When he was 10 he quit school to work full-time. Shortly thereafter his father left home. Because his mother could not support the family she sent his sister to live with relatives keeping him and his two brothers. The three boys stayed in school for a short time then left to find work to support the family.

Lewis went to work for a law firm that assisted inventors in applying for patents. An inventor must apply for a patent from the federal government so that others won't steal his product. In order to apply for a patent, drawings must be made of the invention. He was fascinated by the drawings made by the draftsmen in the law firm. He would watch them for hours. Eventually, he purchased a set of drawing tools and books so that he could teach himself to draw. During the evenings after work, he taught himself drafting. Later, when he felt he was ready, Lewis persuaded his employer to let him make the drawings for an invention. After the employer saw what Lewis could do, he promoted him to the position of junior draftsman. Now he was doing what he wanted to do as his full-time job.

Lewis' office was located near the school building where Alexander Graham Bell conducted experiments. Alexander and Lewis met and became friends. Alexander asked him to create the drawings that were needed in order to get the patents on his inventions. Lewis was happy to work with Alexander.

Other than being a draftsman, Lewis Latimer was interested in becoming an inventor. In 1880 he worked for the United States Electric Lighting Company. It is here that he invented an inexpensive way of making filaments for the light bulb, and in 1882 he received his own patent for this invention. It was in 1883 that he began working directly with Thomas Edison as an engineer and draftsman. Lewis' dream of being an inventor had come true. He became a member of the most famous team of inventors, the Edison Pioneers.

In addition to his work, Lewis loved to write. He wrote the first book on electrical lighting, *Incandescent Electric Lighting*. In this book he discussed the different parts and process of electric lighting. He also wrote poetry which was published by his friends and family when he was 75.

Lewis Latimer made the most of the opportunities he had. He was a self-educated man. When he was working in his first job, he saved his money in order to buy the tools and books necessary to learn the trade of drafting. He spent many hours watching and learning. He practiced until he achieved his dream.

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1. How did Lewis Latimer's early experience and family life influence his career?
2. Although chiefly a draftsman and electrical engineer, Lewis Latimer patented a number of unique inventions. Name and describe two features that made them special.
3. Discuss Lewis Latimer's relationship with Alexander Graham Bell and Thomas Edison.
4. Lewis Latimer was largely self-taught. What training and educational background would be required to pursue a similar career today?

NORMAN R. BLISS
1937-

Mechanical and Civil Engineer

"If you look at things as obstacles, you look at them the wrong way. See them as opportunities that need to be climbed."

When Norman Bliss was a young boy he loved to take things apart and put them back together again in order to figure out how they worked. He also enjoyed reading science fiction books.

During his high school years, Norman loved to work on cars. After school he would restore old cars or tune up his father's car. He became interested in a career in technology because of a course he took in high school.

All through school Norman's grades were good. He was a "straight-A" student. It was because of his high expectations that he wanted to do more than what was required by his parents, so he was active in school sports and student affairs.

When Norman was preparing for college, his high school guidance counselor discouraged him from entering the engineering field. He remembers his counselor telling him that the world wasn't ready for a Negro engineer. Luckily, he didn't listen to his counselor's advice.

In college, Norman soon realized that he was ill-prepared for his classes. Not having taken advanced math courses while in high school, his grades went from "straight-A's" in high school to "D's" in college. It was hard work that brought his grades up and got him through college. He received a bachelor's degree from Case Institute of Technology. He continued his education and graduated with a master's degree from Western Reserve University.

Norman Bliss is now president of Polytech Inc. This company designs buildings, rapid rail systems, highways, dams, airports, sewer systems and many other things. In 1980, his company was chosen as "Minority Firm of the Year" by the Cleveland Urban League and in 1983 awarded "Minority Business of the Year" by the U.S. Department of Commerce.

He still finds time in his busy schedule to do one of the things he enjoyed as a young boy, fix cars. He also is involved in a program that helps Cleveland-area children explore engineering as a career.

It is Norman Bliss' determination that got him through tough challenges. When he didn't like the grades he was getting, he worked even harder. He decided, from the beginning, that engineering was what he really wanted to do, and he didn't let discouraging advice from others deter him from his dream.

---

1. How did Norman Bliss' early experiences prepare him for a career in engineering?
2. How did Norman Bliss turn obstacles into opportunities in his own life?
3. What does Norman Bliss do to help black youth in the Cleveland area?
4. Can you think of any other things engineers do? List them.

CHRISTINE M. DARDEN
1942-

Mechanical Engineer

"Most of what you obtain in life will be because of your discipline. Discipline is perhaps more important than ability."

As a child, Christine Darden was always trying to fix things. Whenever her bike was broken, she wanted to fix it. Her father encouraged this interest and bought her a set of tools.

In high school, Christine knew she liked math. However, she wasn't able to fully pursue her interest in the subject because advanced courses in math were not offered.

In college, Christine wanted to major in math. Her father, though, encouraged her to get a teaching degree because more jobs were available for black women in this area than in math. Because she loved math so much, yet wanted a job, she took classes in education and took the same courses other students were taking who were majoring in math. While in college, Christine was involved in many organizations, including a sorority, women's athletic association, the field hockey team, and president of the Student Christian Association. She graduated in 1962 with a teaching degree and had a strong background in math.

From 1962 to 1965, Christine was a high school math teacher in Virginia. In 1966 she was an instructor at Virginia State College. It was at Virginia State College that she received a master's degree in mathematics in 1967.

Christine started work at NASA as a mathematician. It was at this time that she became interested in engineering. She was fascinated with what the Engineering Department at NASA was doing. It was as a result of this that she went back to school to earn a Ph.D. in engineering. Her switch from math to engineering was difficult to make. People at NASA were not supportive of the idea. At the time she decided to make this switch, not many black women were in the engineering field. It was through her determination that she was able to change the minds of the people at NASA. When she changed from math to engineering, she got back into something she loved as a child, trying to fix things. She finished her doctoral degree in 1983 at George Washington University.

Christine Darden now works as an aerospace engineer and designs the wings of aircraft. She is working on a project that involves designing a supersonic plane that can fly faster than the speed of sound without creating the loud noise called a sonic boom. Because of sonic booms, supersonic planes are banned from flying over the U.S.

It is important to remember Christine Darden's determination. Even though she was discouraged from switching from math to engineering, she held fast to her decision. It is because of this determination that she has achieved her goal of becoming an engineer.

1. How did Christine Darden's early experiences prepare her for a technical career?
2. What educational background is required for a career in aerospace engineering?
3. What attitudes did Christine Darden encounter when she decided to change her career path from math to engineering?
4. Discuss the environmental impact of her work with supersonic aircraft.

Bioengineer and Plastic Surgeon

"The important thing in order to succeed in any course is to become genuinely interested and knowledgeable about the subject. You have to become interested before you can enjoy learning."

Raphael Lee became interested in physics during high school when he found a fascinating book on physics. His motivation for physics came from within himself. It wasn't until he was a senior in high school that he was able to take his first physics course.

Outside of school Raphael was interested in electronics. He built a ham radio and joined several clubs such as the Junior Engineering and Technical Society.

When Raphael graduated from high school he entered the University of South Carolina. He decided to focus on the area of electrical engineering. It was during college that he became interested in lasers. He was especially interested in how lasers could be used in medicine. It was this interest that led him into medical school.

Raphael went on to pursue his interest in medicine and engineering simultaneously. In 1975, he received a master's degree from Drexel University and a doctor of medicine degree from Temple University. He received his Ph.D. from Massachusetts Institute of Technology in bioengineering in 1978.

In September of 1982, Raphael Lee was appointed Harvard Medical School resident and research scientist in the Electrical Engineering Department at Massachusetts Institute of Technology. In that same year, he received a grant from the MacArthur Foundation—awarded to those scientists with exceptional abilities. This grant lasted until 1986 and gave him the financial freedom to begin his own research on cells and how they sense change.

Raphael Lee is now a professor of plastic surgery for the Harvard School of Medicine and a professor of electrical engineering and bioengineering for Massachusetts Institute of Technology. Currently he is working on understanding how electrical and mechanical stresses affect the growth of muscles. Because of his interest in science, technology, and medicine he has brought new techniques to the medical field. As a result of this research the production of muscle tissue substitutes are becoming possible.

It is important to remember Raphael Lee's determination and enjoyment from learning. Even though he did not attend a good grade school or high school, he kept pushing towards his dream.

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1. How does Raphael Lee's career allow him to combine his interests in engineering and medicine simultaneously?
2. Describe the project for which he received his research grant.
3. One future application of Raphael Lee's work might be in the weightless environment of outerspace. Why would NASA be interested in the problem of mechanical stress and tissue growth or loss?
4. Combine two of your interests and think of as many career possibilities as you can that incorporate those two interests.

CAREER PATHS IN ENGINEERING

STARTING OUT

WHAT GIVES A BRIDGE ITS STRENGTH?

Build some model bridges at home out of different materials. How much weight can each one support?

HOW DOES A FLASHLIGHT WORK?

Take apart a flashlight. How does electricity flow from the battery through the light bulb and back?

CURIOSITY

MAKE GOOD CHOICES

. . . make your dreams come true

. . . set aside a time for studying

. . . do a Science Fair project

. . . apply to college as soon as you could

DREAM BIG

GOOD PLANS HELP YOUR CAREER

1

Take these important courses in high school:

Math
Algebra I
Algebra II
Geometry
Trigonometry
Calculus
Computer Programming

Foreign Language
2 years of a foreign language, preferably German, Russian, Latin, or French

Science
Biology
Chemistry
Physics
Advance Placement (AP) course in your favorite science

English
Literature
Composition
Speech

2

Take all of the important exams that colleges require:

SAT and ACT
Take the **Scholastic Aptitude Test (SAT)**, the **American College Test (ACT)**, or both in your junior or senior year. Colleges use the results of these important exams along with your grades to judge your application.

PSAT
In your junior year, take the **Preliminary Scholastic Aptitude Test (PSAT)**. It will give you practice for taking the SAT.

High scores on the PSAT and SAT, plus a high grade average, may allow you to win a National Merit Scholarship (for outstanding high school students), or a National Achievement Scholarship (especially for outstanding black students).

3

Make special arrangements with a community college if your high school doesn't offer some courses.

Visit a college campus, and find out if they have any special summer or pre-college programs.

Study hard for good grades! Earn your high school diploma.

FULFILLING A DREAM

BUILDING YOUR CAREER IN ENGINEERING

HIGH SCHOOL

RODMAN
helps instrumentman on surveying team to determine distances and boundaries between pieces of land.

CARPENTER
builds things out of wood and plastics.

MACHINIST
uses machines to shape parts out of metal.

CONSTRUCTION WORKER
builds buildings or structures from engineers' plans and drawings.

LINEMAN
installs and repairs parts in electrical power lines and systems.

SUBSTATION CONSTRUCTION MECHANIC
keeps electrical substation working well.

MECHANIC
keeps machines running well.

ELECTRICIAN
keeps electrical equipment running well.

TECHNICAL SCHOOL, COMMUNITY COLLEGE, OR ARMED FORCES

DRAFTSMAN
makes detailed drawings of engineering designs.

ELECTRONICS TECHNICIAN
installs and repairs electronic equipment.

MECHANICAL TECHNICIAN
drafts designs and makes tools for engineers.

CHEMICAL TECHNICIAN
carries out laboratory experiments for chemists.

ENGINEERING TECHNICIAN
prepares drawings of new designs and figures out how much it would cost to build them.

AUXILIARY OPERATOR
helps operator of nuclear power plant.

BACHELOR'S DEGREE

4 YEARS OF COLLEGE

AIR TRAFFIC CONTROLLER
watches planes on radar equipment and guides them toward safe landings and takeoffs.

ENGINEERING TECHNOLOGIST
uses engineers' plans to improve how things are done in a factory.

ELECTRONICS TECHNICIAN
installs and repairs electronic equipment.

ELECTRICAL ENGINEER
uses a knowledge of how electrons flow to design equipment, such as computers, that will do particular tasks very precisely.

ELECTRONICS ENGINEER
uses a knowledge of how electrons flow to design equipment, such as computers, that will do particular tasks very precisely.

MECHANICAL ENGINEER
studies how physical things work and then designs machines to make life easier.

CHEMICAL ENGINEER
improves how a factory reacts large volumes of chemicals together to make products.

CIVIL ENGINEER
designs roads, bridges, tunnels, and public buildings, and plans for future needs.

STRUCTURAL ENGINEER
studies the physical characteristics of materials and decides how they should be used in construction.

NUCLEAR ENGINEER
designs equipment and solves problems to control and use nuclear energy.

INDUSTRIAL ENGINEER
organizes the workers, equipment, and materials that make products in a factory.

AGRICULTURAL ENGINEER
designs machines and solves problems about growing, processing, and delivering food to stores.

MASTER'S DEGREE

2 TO 3 YEARS BEYOND COLLEGE

CIVIL ENGINEER
designs roads, bridges, tunnels, and public buildings, and plans for future needs.

ELECTRICAL ENGINEER
designs equipment that transports electricity or runs on electrical energy.

ELECTRONICS ENGINEER
uses a knowledge of how electrons flow to design equipment, such as computers, that will do particular tasks very precisely.

CHEMICAL ENGINEER
improves how a factory reacts large volumes of chemicals together to make products.

BIOENGINEER
applies engineering principles to living things.

NUCLEAR ENGINEER
designs equipment and solves problems to control and use nuclear energy.

Ph.D.

4 TO 7 YEARS BEYOND COLLEGE

UNIVERSITY

RESEARCH ENGINEER
studies basic engineering principles and ways to apply them.

PROFESSOR
teaches engineering principles to students and does research.

ADMINISTRATOR
manages university and department professors and the courses they teach.

INDUSTRY

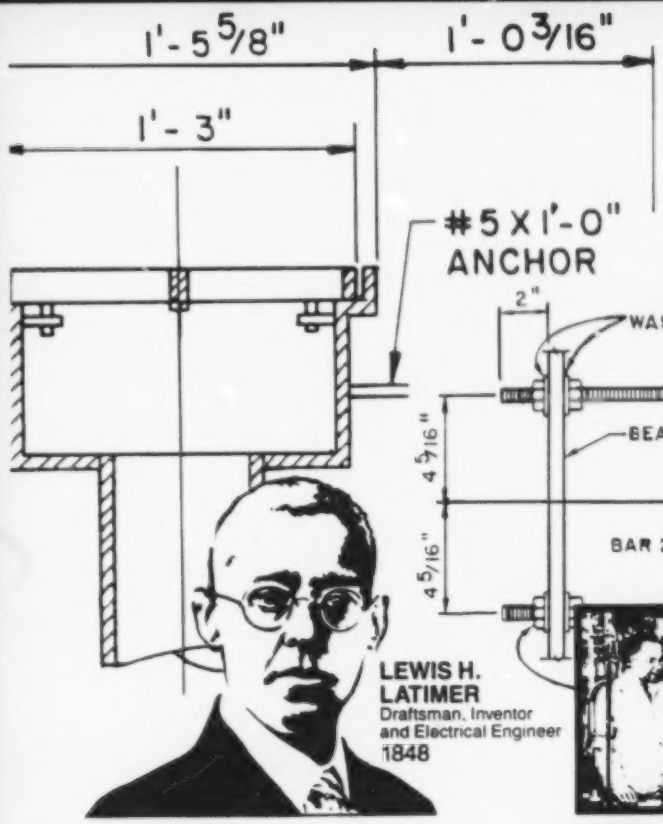
RESEARCH ENGINEER
studies basic engineering principles and ways to apply them.

ADMINISTRATOR
manages scientists and their research projects.

GOVERNMENT

ADMINISTRATOR
manages scientists and their research projects.

RESEARCH ENGINEER
studies basic engineering principles and ways to apply them.



LEWIS H. LATIMER
Draftsman, Inventor and Electrical Engineer
1848

PERCY JULIAN
Organic Chemist
1899

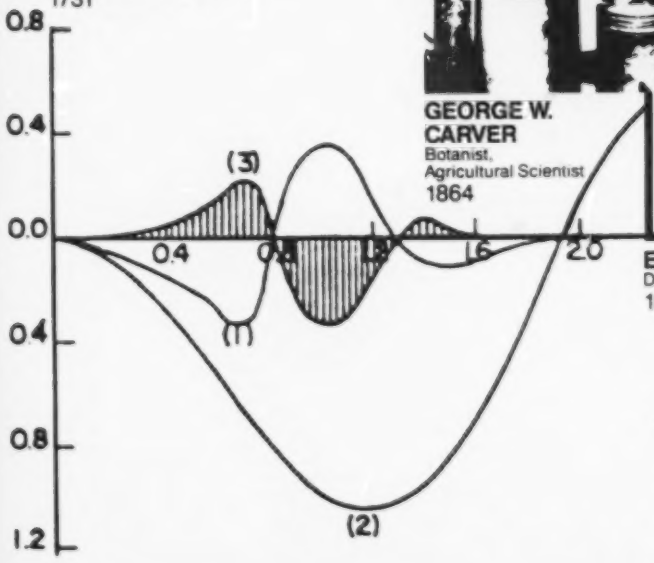
DAVID H. BLACKWELL
Statistician
1919

NORMAN BLISS
Mechanical and Civil Engineer
1937

BENJAMIN BANNEKER
Mathematician, Astronomer
1731

GEORGE W. CARVER
Botanist, Agricultural Scientist
1864

WARREN M. WASHINGTON
Atmospheric Scientist
1936



ERNEST E. JUST
Developmental Biologist
1883

$$v - \frac{1}{n} \sum_{x \varepsilon U} \xi^*(x) \sum_{x \varepsilon C(U_n)} \xi^*(x)$$

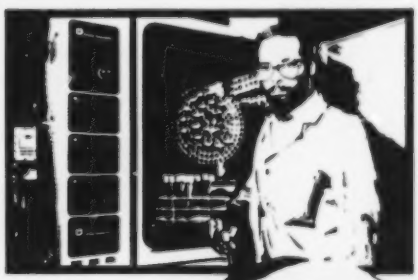
n

CHRISTINE M. DARDEN
Mechanical Engineer
1942

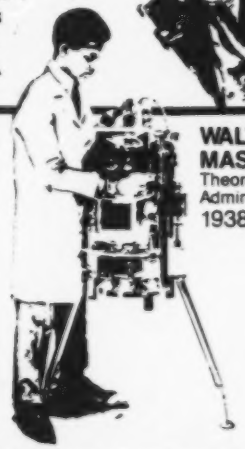
HARVEY M. PICKRUM
Microbiologist
1943

RAPHAEL C. LEE
Bioengineer,
Plastic Surgeon
1949

MARC R. HANNAH
Computer Graphics Architect
1956



FERN Y. HUNT
Mathematician
1948



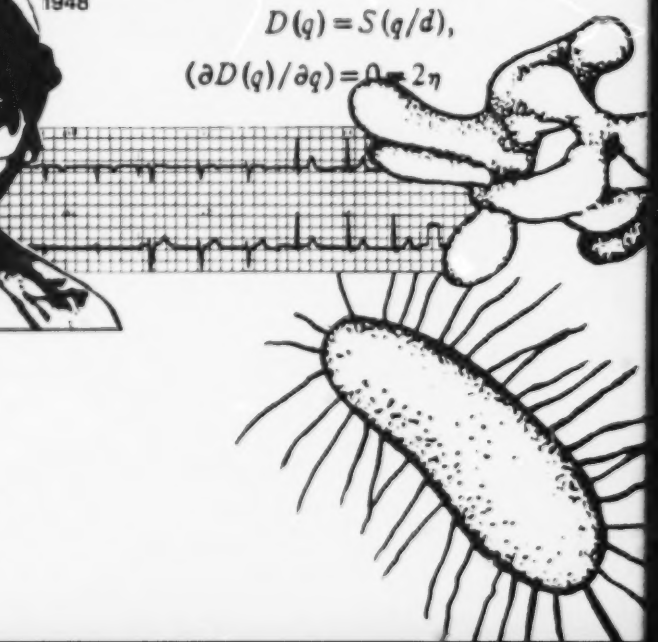
WALTER E. MASSEY
Theoretical Physicist,
Administrator
1938

GEORGE R. CARRUTHERS
Astrophysicist
1939

PATRICIA COWINGS
Psychophysiologist
1948

$$D(q) = S(q/d),$$

$$(\partial D(q)/\partial q) = 0 = 2\eta$$



PROFESSIONAL ORGANIZATIONS

These organizations can supply additional information on technical careers and the paths to achieving them.

1. **Accreditation Board for Engineering and Technology**
   345 East 47th Street, New York, NY 10017 212/705-7685
2. **Alliance for Engineering in Medicine and Biology**
   1101 Connecticut Avenue, N.W., Washington, D.C. 20036
   202/857-1199
3. **American Association of Blacks in Energy**
   1220 L Street, N.W., Suite 605, Washington, D.C. 20005
   202/898-0828
4. **American Astronomical Society Education Office**
   1816 Jefferson Place, N.W., Washington, D.C. 20036
   202/659-0134
5. **American Chemical Society Career Services**
   1155 16th Street, N.W., Washington, D.C. 20036
   202/872-4600
6. **American Geological Institute**
   4220 King Street, Alexandria, VA 22302 703/379-2480
7. **American Geophysical Union**
   2000 Florida Avenue, N.W., Washington, D.C. 20009
   202/462-6903
8. **American Institute of Architects Affirmative Action Committee**
   1735 New York Avenue, Washington, D.C. 20006
   202/626-7300
9. **American Institute of Biological Sciences**
   730 11th Street, N.W., Washington, D.C. 20001
   202/628-1500
10. **American Institute of Chemical Engineers**
    345 East 47th Street, New York, NY 10017 212/705-7338
11. **American Institute of Industrial Engineers**
    25 Technology Park/Atlanta, Norcross, GA 30071
    404/449-0460
12. **American Institute of Physics**
    335 East 45th Street, New York, NY 10017 212/661-9404
13. **American Physical Society**
    335 East 45th Street, New York, NY 10017 212/682-7341
14. **American Psychological Association Educational Affairs Office**
    1200 17th Street, N.W., Washington, D.C. 20036
    202/955-7600
15. **American Society for Horticultural Science**
    701 North Saint Asaph Street, Alexandria, VA 22314
    703/836-4606
16. **American Society for Engineering Education**
    Suite 200, One Dupont Circle, Washington, D.C. 20036
    202/293-7080
17. **American Society for Quality Control Education and Training Institute**
    Suite 7000, 230 West Wells Street, Milwaukee, WI 53203
    414/272-8575
18. **American Society of Biological Chemists**
    9650 Rockville Pike, Bethesda, MD 20814 301/530-7145
19. **American Society of Mechanical Engineers**
    345 East 47th Street, New York, NY 10017 212/705-7722
20. **American Society of Microbiology**
    1913 I Street, N.W., Washington, D.C. 20006
    202/833-9680
21. **American Statistical Association**
    806 15th Street, N.W., Washington, D.C. 20005
    202/393-3253
22. **Botanical Society of America**
    c/o Dr. David L. Dilcher, Secretary
    Dept. of Biology
    Indiana University
    Bloomington, IN 47405
    812/335-9455
23. **Institute of Electrical and Electronics Engineers, Inc.**
    345 East 47th Street, New York, NY 10017 212/705-7900
24. **Institute of Mathematical Statistics**
    3401 Investment Boulevard, No. 7, Hayward, CA 94545
    415/783-8141
25. **Mathematical Association of America**
    1529 Eighteenth Street, N.W., Washington, D.C. 20036
    202/387-5200
26. **National Action Council for Minorities in Engineering, Inc.**
    3 West 35th Street, New York, NY 10001 212/279-2626
27. **National Association of Mathematicians Department of Mathematics**
    Atlanta University Atlanta, GA 30314 404/681-0251
28. **National Council of Teachers of Mathematics**
    1906 Association Drive, Reston, VA 22091 703/620-9840
29. **National Institute of Science**
    c/o Arthur C. Washington
    Prairie View A & M University
    Praire View, TX 77446
    409/857-2315
30. **National Network of Minority Women in Science American Association for the Advancement of Science**
    1333 H Street, N.W., Washington, D.C. 20005
    202/326-6677
31. **National Organization for the Professional Advancement of Black Chemists and Chemical Engineers**
    c/o Dr. Charles Meredith
    Atlanta University Center
    360 Westview Drive, S.W.
    Atlanta, GA 30314
    404/522-8980
32. **National Society of Black Engineers**
    101 Connecticut Avenue, N.W., Washington, D.C. 20036
    202/857-1100
33. **National Technical Association**
    733 15th Street, N.W., Washington, D.C. 20005
    202/638-6370
34. **Office of Opportunities in Science American Association for the Advancement of Science**
    1333 H Street, N.W., Washington, D.C. 20005
    202/326-6600
35. **Organization of Black Scientists, Inc.**
    Department of Chemistry
    c/o Dr. John Hall
    Atlanta University
    223 Chestnut Street, S.W.
    Atlanta, GA 30314
    404/681-0251
36. **Society of Automotive Engineers**
    400 Commonwealth Drive, Warrendale, PA 15086
    412/776-4841
37. **Society of Exploration Geophysicists**
    P.O. Box 702740, Tulsa, OK 74170
    918/493-3516
38. **Society of Women Engineers**
    United Engineering Center, Room 305
    345 East 47th Street, New York, NY 10017
    212/705-7855

CAREER PUBLICATIONS

The following career guidance publications are included to highlight the variety of options available and to help young people prepare for a scientific or technical career.

1. *Career Development Needs of Thirteen-Year Olds* by Roger F. Aubrey, Alexandria, VA, American Association for Counseling and Development, 1978.
2. "Careers in Biology: A Special Report by the American Institute of Biological Sciences and the National Association of Biology Teachers" by Roy H. and Barbara W. Saigo, Carolina Biological Supply, 1983.
3. "Careers in Botany" Committee on Education of the Botanical Society of American. Revised by Roy H. and Barbara W. Saigo (University of Wisconsin—Eau Claire).
4. "Careers in Computing" by Rachael Wrege, Popular Computing, (June 1983) vol. 2, No. 8, pp. 124-136.
5. *Careers in Conservation* by Ada and Frank Graham, New York, Scribner, 1980.
6. *Careers in Consumer Protection* by Sterling McLeod, New York Messner, 1974.
7. *Careers in Environmental Protection* by Reed Millard, New York, Messner, 1977.
8. "Careers in Geodesy," "Careers in Geophysics," and "Careers in Oceanography"Prepared by the American Geophysical Union. 1986.
9. "Careers in Geology" American Geological Institute and American Association fo Petroleum Geologists.
10. *Careers in Health Services* by Diane Seide, New York, Dutton, 1982.
11. *Careers in Horticultural Sciences* by Dorothy and Joseph Dowell, New York, Messner, 1975
12. "Careers in Statistics" American Statistical Association.
13. *Careers in the Animal Kingdom* by Walter Oleksky, New York, Messner, 1980.
14. *Careers in the Earth Sciences* by Reed Millard, New York, Messner, 1980.
15. "Careers in the Electrical, Electronics and Computer Engineering Fields"Institute of Electrical and Electronic Engineers.
16. *Careers: New and Unique* by Sarah Splaver, New York, Messner, 1979.
17. *Careers: Working with Animals* by Guy R. Hodge, Washington, D.C., Humane Society/Acropolis Books, 1979.
18. *Chemical Careers* by L.B. Taylor, New York, Franklin Watts, 1978.
19. *Comets: Career Oriented Modules to Explore Topics in Science* vol. I: "Profiles"; vol. II: "Science" Washington, D.C., National Science Teachers Association, 1984.
20. *Computer Careers Handbook* by Connie Winkler, New York, Arco, 1983.
21. *Current Career and Occupational Literature* by Leonard H. Goodman, New York, Wilson, 1984.
22. *Day in the Life of Marine Biologist* by William Jaspersohn, Boston, Little Brown, 1982.
23. *Day in the Life of a Veterinarian* by William Jaspersohn, Boston, Little Brown, 1978.
24. *Energy: New Shapes/New Careers* by Reed Millard, New York, Rosen, Pub. Group, 1982.
25. *Exploring Careers in Computer Graphics* by Richard Masterson, New York, Rosen Pub. Group, 1987.
26. *Exploring Careers in Science* by Stanley J. Shapiro, New York, Rosen Pub. Group, 1983.
27. *Exploring Careers in Research and Development in Industry* by Mary Price Lee, New York, Rosen Pub. Group 1983.
28. *Exploring Environmental Careers* by Stanley J. Shapiro, New York, Rosen Pub. Group, 1985.
29. *Futuristic Careers: Jobs Today in the 21st Century Fields* by Tese W. Marrs, Glenview, IL, Scott, Foresman, 1988.
30. *Here's Your Career: Veterinarian* by Frank Stilley, New York, Putnam, 1976.
31. *How To Be An Inventor* by Harvey Weiss, New York, Crowell, 1980.
32. *How To Help Your Child Plan A Career* by Dean L. Hummell and Carl McDaniels, Washington, D.C., Acropolis, 1979.
33. *Idea Book on Meeting the Occupational Information Needs of Disadvantaged Youth* Portland, OR, Northwest Regional Educational Laboratory, (n.d.)
34. *Ms. Engineer* by Margaret Harmon, Philadelphia, Westminster Press, 1979.
35. *Ms. — M.D.* by D.X. Fenten, Philadelphia, Westminster Press, 1975.
36. *Occupational Outlook Handbook, 1986-87* 17th Ed., U.S. Department of Labor, Bureau of Labor Statistics, 1987.
37. *Opportunities in Biological Sciences* by Charles A. Winter, Lincolnwood, IL, National Textbook Company, 1984.
38. "Physics in Your Future" by Dinah Moche. Committee on the Status of Women in Physics of the American Physical Society.
39. *Planning My Career, Occupational Guidance* by Vincent Capozziello, Jr., Minneapolis, MN, Finney Co., 1985.
40. *Robotics Careers* by Ellen Thro, New York, Franklin Watts (High-tech Careers Ser.), 1987.
41. *Scientists Who Work Outdoors* by Lynn and Gray Poole, New York, Dodd Mead, 1963.
42. *They Work With Wildlife* by Edward R. Ricciuti, New York, Harper, 1983.
43. "Understanding the Universe: A Career in Astronomy"Published by the American Astronomical Society, Education Office, October 1986.
44. *What Color Is Your Parachute* by Richard N. Bolles, Berkeley, CA, Ten Speed Press, 1986.
45. *What Does A Geologist Do?* by R.V. Fodor, New York, Dodd Mead, 1977.
46. *Where To Start: An Annotated Career Planning Bibliography 1985-87* 5th Ed., by Madeline T. Rockcastle, Princeton, NJ, Petersons Guides, 1985.
47. *The World of Work: Careers and the Future* by Howard Didsbury, Bethesda, MD, World Future Society, 1983.
48. *Your Career in the Drug Industry and Pharmacy* by David J. Gaulich, New York, Arco, 1982.

BIBLIOGRAPHY

The following titles were used in compiling this booklet and may serve as supplementary readings concerning the sixteen black achievers profiled in the text.

1. *American Black Scientists and Inventors* ed. by Edward Jenkins, Washington, D.C., National Science Teachers Association, 1975.
2. *At Last Recognition: A Reference Handbook of Unknown Black Inventors and Their Contributions to America* by James C. Williams, Chicago, B.C.A. Pub. Co., 1978.
3. *Banneker, The Afro-American Astronomer* ed. by Will W. Allen, Freeport, NY, Books for Libraries, 1969.
4. *The Bannekers of Bannaky Springs* by Deloris Harrison, New York, Hawthorn Books, 1970.
5. *Benjamin Banneker: Genius of Early America* by Lillie Patterson, Nashville, Abingdon, 1978.
6. *Black Apollo of Science: The Life of Ernest Everett Just* by Kenneth R. Manning, New York, Oxford, 1983.
7. *Black Giants in Science* by Paul J. Driver, New York, Vantage, 1973.
8. *Black Inventors of America* by McKinley Burt, Portland, Oregon, National Book Company, 1969.
9. *Blacks in Science: Astrophysicist and Zoologist* by Hattie Carwell, Hicksville, NY, Exposition, 1977.
10. *Blacks in Science: Ancient and Modern* ed. by Ivan Van Sertima, New Brunswick, NJ, Transaction Books, 1983.
11. *Black Mathematicians and Their Work* by Virginia Newell, Ardmore, PA, Dorrance and Co., 1980.
12. *Black Pioneers of Science and Invention* by Louis Haber, New York, Harcourt, 1970.
13. *Dictionary of American Negro Biography* ed. by Rayford W. Logan and Michael R. Winston, New York, Norton, 1982.
14. *Dr. George Washington Carver, Scientist* by Shirley Graham and George D. Lipscomb, New York, Washington Square Press, (n.d.).
15. *Eight Black American Inventors* by Robert C. Hayden, Reading, MA, Addison-Wesley, 1972.
16. "From Dreams to Reality: A Tribute to Minority Inventors" U.S. Department of Commerce Patent and Trademark Office.
17. *George Washington Carver: the Story of a Great American* by Ann Terry White, Eau Claire, WI, E.M. Hale, 1953.
18. *Great Negroes Past and Present* by Russell Adams, Chicago, Afro-Am, 1969.
19. *Hidden Contributors: Black Scientists and Inventors in America* by Aaron Klein, Garden City, NY, Doubleday, 1971.
20. "Just In The Middle," in *The Flamingo's Smile* by Stephen Jay Gould, New York, Norton, 1985.
21. *Legacy For All: A Record of Achievement* by Black American Scientists Western Electric.
22. *Life of Benjamin Banneker* by Silvio A. Bendini, New York, Little Brown, 1954.
23. *Many Shades of Black* ed. by Stanton L. Wormley and Lewis H. Fenderson, New York, Morrow, 1969.
24. *The Negro In Science ed. by Julius Taylor, Baltimore, MD, Morgan College Press, 1955.*
25. *"The Negro Benjamin Banneker, Astronomer and Mathematician, Plea For Universal Peace" by Phillip LePhillips, Record of the Columbian Historical Society* vol. 20 (1971), pp. 114- 120.
26. *Negroes Who Helped Build America* by Madeline Stratton, Lexington, MA, Ginn & Company, 1965.
27. *Pocketful of Goobers: A Story About George Washington Carver* by Barbara Mitchell, Minneapolis, MN, Carolrhoda, 1986.
28. "The Real Benjamin Banneker," by William B. Settle, *Negro History Bulletin* vol. 16, 1953.
29. *Shortchanged by History: America's Neglected Innovators* by Vernon Pizer, New York, Putnam, 1978.
30. *The Story of George Washington Carver* by Arna Bontemps, New York, Grosset & Dunlap, 1954.
31. *They Showed The Way* by Charlemae Rollins, New York, Crowell, 1964.

LEWIS H. LATIMER

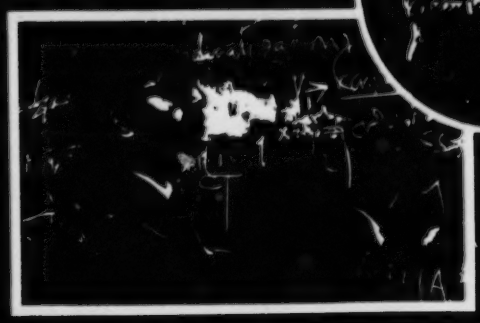
1848

PERCY JULIAN

1899

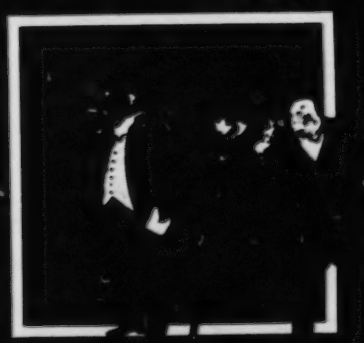
DAVID H. BLACKWELL

1919



NORMAN BLISS

1937



BENJAMIN BANNEKER

1731

GEORGE W. CARVER

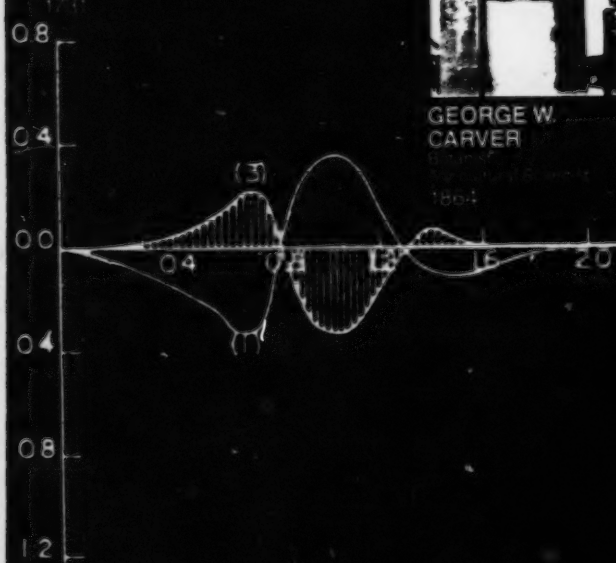
1864

ERNEST E. JUST

1883

WARREN M. WASHINGTON

1936



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